THE DEVELOPMENT OF MODERN ARTILLERY AND EXPLOSIVES.[1]

THIS volume is a re-publication of the many valuable papers and lectures which Sir Andrew Noble has contributed on the subject of artillery and explosives. Everyone recognises that there is no greater authority on these subjects than the author, and certainly the marvellous development of heavy weapons within the last forty years would have been impossible but for the solid scientific foundations which Noble and his colleagues laid down. His has been a career of activity almost unequalled, his investigations extending from the period when he was secretary to the first Committee on Rifled Cannon (1858) down to the present time, when Sir Andrew Noble still serves on the Ordnance Research Board, and only last year contributed further valuable papers on the combustion of certain smokeless powders.

As illustrating the development in gun construction which has taken place during this period, it may be mentioned that the heaviest gun in use when Sir Andrew first joined the service was a cast-iron weapon weighing 95 cwt. and firing a round shot of 68 lb. weight, with a muzzle velocity of 1600 feet per second. A comparison of this with the enormous velocities, energy, and range of modern weapons, such as form the heavy armament of our present-day battleships, clearly shows that these advances could only have been made as the result of careful scientific experiment. Noble, together with his colleague the late Sir Frederick Abel, will ever be associated as the leading minds in this magnificent experimental work.

The apology which the author makes for this re-publication is therefore quite unnecessary, and all interested in the subject will gladly welcome this volume, for the papers and lectures were delivered before such various societies that it is often difficult to obtain access to the whole of them. Necessarily there arises a certain amount of repetition, but, as pointed out, the elimination of this would practically have meant re-writing the work, so that the papers appear precisely in their original form. Not only will the collection of them prove of value to the technical man, but several will appeal to the general reader, notably those on "The Rise and Progress of Rifled Naval Artillery," and "Mechanical Science in Relation to the Naval and Military Services."

The preface alone is most interesting, and might well be quoted at length. Two points only, however, which throw light on the objection to any change in the old days, may be noted. After the introduction of rifled artillery, a dinner was given by the Royal Artillery mess to the late Lord Armstrong. After eulogising the work done by the guest of the evening, the president concluded with the emphatic statement, "for myself I am radically opposed to any change." Again later, when Artillery officers were pressing for the introduction of a naval gun weighing seven tons, the naval officers "doubted whether so heavy a gun could be carried on board ship," and a compromise was effected by introducing a gun of 6½ tons. Yet we have had vessels, the *Sans Pareil* and *Benbow* (both long since obsolete), carrying two 110-ton guns!

The first paper deals with the "Application of the Theory of Probabilities to Artillery Practice," and afforded valuable information as to the superiority of rifled ordnance. The paper is a mathematical one based on actual firing results, the object being to determine "for each gun, that area within which, if a given number of shots were fired, half of the number might be expected to fall." This paper is followed by one on "Experiments with Navez's Electroballistic Apparatus." Other papers of similar type are those "On the Ratio between the Forces tending to produce Translation and Rotation in the Bores of Rifled Guns" and "On the Pressures required to give Rotation to Rifled Projectiles," in which the relative behaviour with uniform and parabolic rifling is critically examined.

To the man of science, as distinct from the artillerist, undoubtedly the researches on the changes taking place during combustion of explosives, the measurement of temperatures, pressures, and velocities will be of the greatest interest. These researches may be said to commence with a paper "On the Tension of Fired Gunpowder" (1871), although part i. of the now classical "Researches on Explosives" did not appear until 1875. As already mentioned, only last year a further contribution under this title was published in the Proceedings of the Royal Society (followed later by a note making certain corrections on temperature estimations), which greatly extended our knowledge on the variation in the products, temperature, &c., when certain modern smokeless powders are fired under varying conditions. It is one of the few points on which we may offer criticism that these two papers are not included in the present volume, and unless some restrictions as to re-publication prevented, it is difficult to understand why they were omitted, for they are certainly not the least valuable of the series.

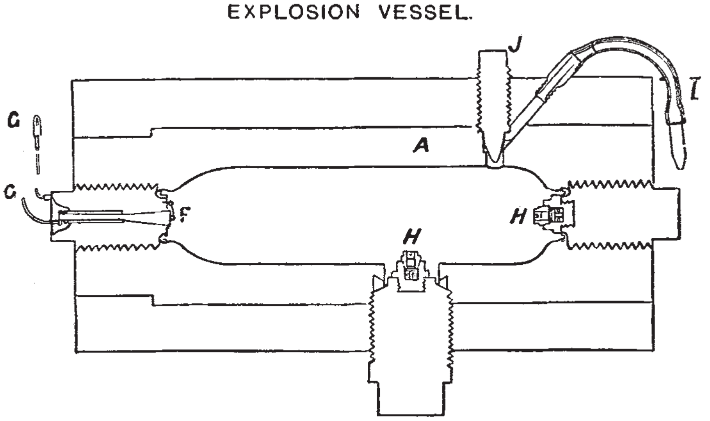

FIG. 1.—Vessel employed for small charges, to enable the gaseous products to be collected and examined. The firing plug is shown at F; the crusher gauges for determining the pressure at H, H; the escape valve for the gases at J.

When Noble and Abel first took up the examination of gunpowder, the knowledge on the subject was simply chaotic. Owing to faulty methods, unjustifiable assumptions, and other causes, the most diverse ideas as to the pressure and temperature developed on firing were held. Rodman, with his well-known "cutter gauge," had done valuable work, but here, as shown in an early paper in this volume, error arose from inertia of the cutter employed. For the examination of the products on firing, charges occupying but a small portion of the space in the experimental vessel had been employed. Sir Andrew Noble and his colleagues fully appreciated the necessity of examining the products when the powder was fired as nearly as possible under like conditions to those existing in the gun, and it was not until they succeeded in retaining all the products when the charge was fired in a space which it completely filled that knowledge on the changes commenced to have any claim to scientific accuracy. Charges so large as 23 lb. of gunpowder and 5 lb. of guncotton have been fired in the author's explosion vessels, illustrations of which we reproduce.

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[1] "Artillery and Explosives" By Sir Andrew Noble, Bart., K.C.B., F.R.S., &c. Pp. xvi+548. (London: John Murray, 1906.) Price 21s. net.

We have become familiar with combustions under these conditions, but it is not difficult to appreciate the risks and troubles incidental to such work, and the patience required by the pioneers to overcome these difficulties. Interesting references will be found to some of these troubles in more than one paper. An account of one singular accident may be quoted:—

"The end of the vessel was placed against a wrought-iron beam. The screw—a half-inch pitch—being a very good fit, was screwed into its place with much difficulty, and with the use of a good deal of oil. On firing, the screw unscrewed . . . until the last two threads were reached. These were sheared. Owing to the wrought-iron beam . . . there was no motion of translation, but the motion of rotation was so high, that the screw first striking the ground and then an iron plate at an angle of 45°, went vertically into the air with a singular humming noise, descending in about 30 seconds a few feet from the place whence it rose."

EXPLOSION VESSEL.

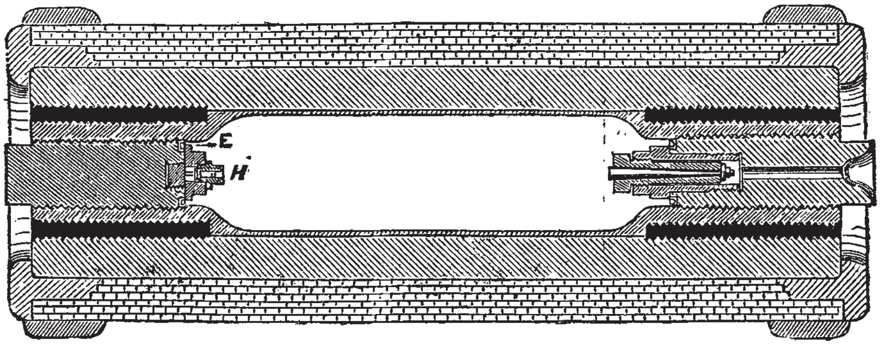

FIG. 2.—Vessel employed for heavy charges. Crusher-gauge is shown at H, the firing plug being situated at the opposite end. The shell proper was strengthened by being wound with steel tape.

Only two points need be mentioned in connection with the researches on gunpowder. The author, adopting and relying on Bunsen and Schischkoff's method for estimating hyposulphites in the residues, regarded potassium hyposulphite as being formed as a primary product during combustion, a conclusion questioned by Berthelot, who regarded it "entirely as a product formed during the collection and analytical treatment of the solid residue." In a controversy which followed, Noble made out a good case for supposing no change to have been possible during the preparation of the material, but appears not to have considered the other possibility, faulty analytical methods. Later Debus showed that this was the case, and that actually the treatment produced hyposulphite, which necessitated a re-calculation of the composition of the residues. Attention might have been directed to this earlier in the book.

No practical method is available for determining the actual temperature of explosion, but making certain justifiable assumptions, calculated temperatures of approximate accuracy may be obtained. With Service gunpowder the author concluded the temperature to be about 2200° C., and regarded the signs of fusion of pieces of platinum in the charge as confirming this, Deville's value of "nearly 2000° C." being taken as the melting point of platinum. Holborn and Wein have more recently shown the melting point to be close to 1780° C., so that possibly the temperatures for gunpowder are somewhat high.

It may be noted that as a direct result of the researches on gunpowder, guns were constructed which advanced the velocities from 1600 to 2100 feet per second.

Although gunpowder held its own for centuries with but slight modification, it has now become a thing of the past as a military propellant explosive. The advantages of a smokeless powder are so great that as soon as the difficulty of "taming" guncotton had been overcome, its adoption, either gelatinised alone or mixed with nitroglycerin, quickly followed. Again Noble and Abel were pioneers in our knowledge of the conditions attending the use of smokeless powders. Naturally the very full and lucid accounts of the large number of experiments made by Sir Andrew Noble and his colleagues will prove of even greater interest than the earlier work on gunpowder. Throughout they enjoyed enviable facilities for actual trials in large experimental guns with full charges, and so were enabled to correlate the values in practice with laboratory experiments.

The changes involved during the combustion of smokeless explosives are less complicated than with gunpowder. Conditions, however, greatly modify the proportions in which the various permanent gases are found, hence the total gas volume is also affected. The influence of increasing amounts of nitroglycerin to nitrocellulose in cordites was first fully worked out by Noble, and has proved of the greatest practical value, since it has a close connection with the important question of erosion. With the introduction of the old form of cordite for large guns, the loss of accuracy and short life of the gun became serious matters for consideration. Noble showed erosion to be due to two causes, (*a*) high temperature of the products, (*b*) the motion of these hot gases. Further, a series of elaborate experiments with specially prepared cordites containing increasing percentages of nitroglycerin showed that increase of temperature went hand in hand with increase of nitroglycerin, and consequently also the erosion.

The logical step, therefore, was to reduce the percentage of nitroglycerin, and, as is now common knowledge, the new M.D. cordite contains only 30 per cent. of nitroglycerin instead of 58 per cent. as in the earlier form. Powder of this composition will, for the same charge and size of cord, give less energy in the gun, but this may be overcome by suitable modification of the charge and size of cord. These points are all made beautifully clear by some excellent coloured plates in the last paper, which was delivered in 1900 at the Royal Institution. Other instructive plates in the same paper are those dealing with velocities and pressures derived from them, in a series of experiments with numerous modern smokeless powders, carried out in a 100-calibre 6-inch gun.

We still employ M.D. cordite in spite of the almost universal adoption by our European neighbours and the Americans of simple nitrocellulose powders, which they experience considerable trouble in keeping in a stable condition, and we may therefore assume that no great advance has been made since Noble's experiments clearly indicated the right path to be followed in the production of a trustworthy smokeless powder which shall give minimum erosion, whilst possessing the essential quality of stability.

J. S. S. B.

A HALF-DOZEN ILLUSTRATED NATURE BOOKS.[1]

IF the lover of natural history and country life whose tastes incline to the study of the higher animals, and who may also possess an appetite for a spice of philosophy, cannot find matter to his liking in at least one of this excellent half-dozen of popular books, he must indeed be hard to please. The first five are charming examples of the modern style of nature-study and popular natural history works, and the general excellence of the style of the text is only equalled (or shall we say surpassed?) by the exquisite illustrations. Since each volume has a special line of its own, we are fortunately spared the invidious task of deciding as to their comparative merits.

The first volume in the list—the forerunner, apparently, of a series of volumes written on the same general lines—is a natural history of mammals, in which, while the group is taken in systematic order, the method of treatment is so popular (and at the same time so accurate) that it can scarcely fail to appeal to a very large series of readers, many of whom will be glad to find it unencumbered, as a rule, with scientific names. The great feature of Mr. Ingersoll's book is, however, formed by the illustrations, many of which—more especially the coloured plates and the reproductions from photographs—are beyond praise. Among the best may be reckoned several of the twelve coloured plates drawn by the author's daughter. Those of the fallow-deer and the jaguar are reproductions from German works, and in the case of these, as well as in that of the water-chevrotain on p. 342, which is copied from an encyclopædia article by Sir W. H. Flower, we fail to notice any acknowledgment of the source. Special attention may be directed to the photo. of the Himalayan tahr on p. 262, as showing the shaggy character of the coat, which is so completely lost in all museum specimens we have seen. On the other hand, it may be noticed that on p. 240 the author gives a figure of the head of an African buffalo to do duty for that of the Indian wild ox or gaur; while the cut of an urial's head on p. 251 is a ludicrous caricature.

In general the text is well up to date, including, for instance, an account of the pedigree of the elephant; but it is rather behindhand in the matter of giraffes, and likewise in classing all antelopes as members of a single subfamily. Moreover, in definitely asserting that the latter animals are recent immigrants into Africa, the author ignores the recent suggestion of Mr. Madison Grant as to the Bovidæ being an endemic Ethiopian group. As instances of error we may refer to an evident mistake in regard to the colour of Pembroke cattle (p. 240), and to the reference of the name "ravine-deer" to the blackbuck (p. 277). These are, however, but trifling slips, and scarcely detract from the general excellence of a most attractive volume.

A Christmas bird-book from the pen and camera of Mr. Kearton is a standing dish to which all young bird-lovers look forward with delight, and we can assure them that they will not be disappointed at the fare their favourite author and artist has provided for the present season. This time Mr. Kearton has taken up his subject from a more definitely systematic point of view than usual, dealing "in a concise and popular manner with the appearance, haunts, habits, nests, eggs, songs, and call-notes of the winged melodists that breed in various parts of the British Islands. I have endeavoured," he continues, "to describe them in such a way that the reader may be able to identify them for himself or herself in wood and field, and where two species bear a similarity of appearance or song, to emphasise the points wherein they differ."

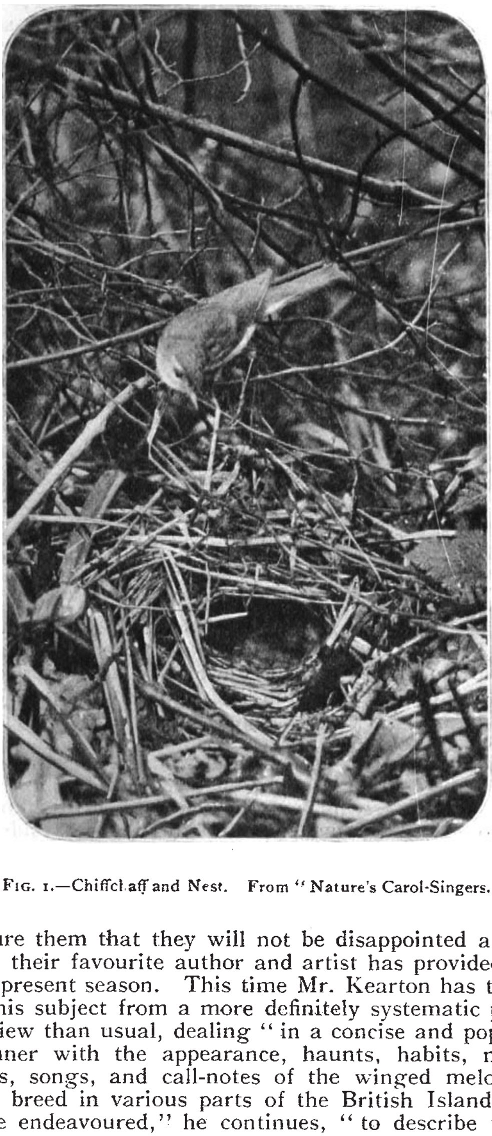

FIG. 1.—Chiffchaff and Nest. From "Nature's Carol-Singers."

In this aim the author appears to have been successful, condensing the necessary technical descriptions

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[1] (1) "The Life of Animals—the Mammals." By E. Ingersoll. Pp. xi+555; illustrated (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) Price 8*s*. 6*d*. net.

(2) "Nature's Carol-Singers." By R. Kearton. Pp. 251; illustrated London: Cassell and Co., Ltd.) Price 6*s*.

(3) "An Idler in the Wilds." By T. Edwardes. Pp. viii+109; illustrated. (London: John Murray.) Price 6*s*. net.

(4) "I Go A-Walking through the Woods and o'er the Moor." Compiled from the works of the late Rev. C. A. Johns and others. Pp. 79; illustrated. (Edinburgh and London: T. N. Foulis.) Price 2*s*. 6*d*. net.

(5) "Brier Patch Philosophy." By "Peter Rabbit." Interpreted by W. J. Long Pp. xvii+296; illustrated. (London: Ginn and Co.) Price 6*s*. net.

(6) "Birds Shown to the Children." By M. K. C. Scott, described by J. A. Henderson. Pp. 112; illustrated. (London and Edinburgh: T. C. and C. E. Jack.) Price 2*s*. 6*d*. net.